CONCEPTUAL FOUNDATIONS FOR DESIGNING INFORMATION SYSTEMS SUPPORTING THE STRATEGIC ANALYSIS OF TECHNOLOGY ENVIRONMENTS

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Abstract

This paper addresses the topic of the assessment of an organization's external environment and more particularly the lack of research providing conceptual foundations for developing suitable strategic information systems supplying managers with the necessary information and analysis tools to consider the key environmental aspects that are relevant to strategic decision making. Inspired by research in the field of domain and enterprise ontologies, this paper argues that the development of a formal model of the environment would help solve this problem. As a result, this paper develops a conceptual model of the environment that assembles the available but scattered knowledge on this topic and translates it into a more formal form that may facilitate the creation of environmental

information systems and tools and demonstrates its usefulness by applying it to analyze a concrete environment.

Keywords: environment scanning, information systems, ontology, design science

1. Introduction

The monitoring of an organization's external environment and the need of devising suitable information systems to support this task are acknowledged by many authors from a variety of disciplines as a key organizational activity.

This is especially the case of the strategic management field, where the co-alignment between the organization and its environment is considered as essential for achieving a satisfactory level of performance. The notion of strategy itself emerged as a response to the rising environmental turbulence to allow businesses to take a stable direction in a rapidly changing environment and sustain their performance (Bourgeois 1980; Ansoff 1987). From this viewpoint, environment scanning is seen as a vital first step in the strategic decision making process providing managers with the necessary information for crafting strategies that are aligned with the environment where they must be implemented (Hambrick 1982; Daft et al. 1984; Beal 2000).

As observed by Barney (1986), the importance of assessing the environment is recognized by the main strategic management approaches: the resource-based view, industrial organization and Schumpeterian approaches. The resource-based view of the firm (Wernerfelt 1984; Barney 1991), argues that a firm's competitive advantage depends on its unique resources and their matching with environmental opportunities and threats (Learned et al. 1965). The industrial organization approach claims that the performance of a business is determined by the structure of its industry and that the essence of strategy is understanding the competitive forces of that

environment to find a position where it can best defend against these forces or influence them favorably (Bain 1968; Porter 1980). Finally, the Schumpeterian approach focuses on the role of innovation in sustaining economic growth through waves of creative destruction that create more valuable products and markets, but also displace established firms that are not able to develop the skills needed to compete in the new market (Schumpeter 1950; Christensen 1997).

The importance of environmental analysis is also demonstrated by the emergence of a dedicated branch within the strategic management discipline focusing on providing decision makers with relevant and timely information about their environment to improve their strategic decisions. This branch, originally called environment scanning after the pioneering works of Dill (1958) and Aguilar (1967) and now often referred as business or competitive intelligence, has studied several aspects like the environment scanning process (Daft et al. 1984; Lesca et al. 1997a; Vedder et al. 1999), the impact on scanning of environmental perceptions (Duncan 1972; Daft et al. 1988; Boyd et al. 1996) and firms' strategic posture (Hambrick 1982; McKee et al. 1989; Jennings et al. 1992), the organization of scanning units (Lenz et al. 1986) and what information sources and target environmental domains are consulted (Gboshal et al. 1986; Daft et al. 1988; Elenkov 1997; May et al. 2000).

On the other hand, the existing research on this topic still has a few important gaps:

- extant research "*has produced no easy methodology for continuous surveillance of the environmental trends of central importance to a firm*" (Andrews 1987, p 39) and especially lacks "*conceptions of environments sufficient for guiding scanning and analysis activities*" (Lenz et al. 1986);
- although the importance of building adapted information systems for environment scanning is often acknowledged in IS (El Sawy 1985; Watson 1990; Choudhury et al. 1997), that

there has been insufficient research on the application of information technology to support this activity. In particular, it is observed that any article discusses the criteria for developing adapted environment scanning information systems and tools (Elofson et al. 1991; Lesca et al. 1997b) and that the non application of information systems methods to this task results in a lack of methods for conceiving such systems, define their requirements or modeling the information objects that must be manipulated by them (Salles 2004).

As a result, one major problem in the conception of environmental information systems is that most research about environment scanning is excessively abstract and vague as compared with the precision needed by information system design, especially regarding the environmental element must be considered. There is hence a need for translating the existing knowledge on these elements into a more appropriate form for information systems development if one wants to supply usable foundations for creating effective tools to support this task.

Inspired by research in the enterprise ontologies field (Uschold et al. 1997; Fox et al. 1998), we argue that the development of a formal conceptual model of the environment would help solve both problems. On the one hand, it provides a reference framework showing what the relevant environmental aspects are and how they fit together; on the other hand it provide more formally defined and hence actionable foundations to facilitate the development of appropriate tools.

Accordingly, the goal of this paper is to develop a conceptual model of the environment that assembles the available but scattered knowledge on this topic and translates it into a more formal form that may facilitate the creation of environmental information systems and tools. This model may be used as a reference to specify environmental system requirements, design the underlying data repository, identify and integrate the various existing tools that can be used for collecting,

analyzing and visualizing such data, and understand where original developments must be made. In this last case, our model might actually promote the development of suitable information systems and tools by providing well defined concepts and models that can be used by developers to conceive and develop original tools.

The remainder of the paper is structured as follows. The next section explains the methodology that we followed to achieve this objective in a rigorous manner. Section 3 defines the set of constructs that are needed to describe and reason about the environment based on a thorough literature review and integrates in a formal conceptual model. Section 4 presents an evaluation of the ability of the model to describe an organization's environment through a case study of its application on a concrete environment. Finally, section 5 concludes the paper by reminding its contributions and proposing some possible research extensions towards the definition of a comprehensive environmental toolbox.

2. Methodology

In this paper we follow a design science approach which proposes the scientific legitimacy of research aiming at creating artefacts that serve human purposes. There are indeed two major scientific paradigms in information systems that "*can be encompassed under a broad notion of science that includes two distinct species termed natural and design science*" (March et al. 1995). The first seeks to "*develop and verify theories that explain or predict human or organizational behavior*", whereas the second seeks to "*creating new and innovative artifacts [that]extend the boundaries of human problem solving and organizational capabilities by providing intellectual as well as computational tools*" (Hevner et al. 2004). In the information systems field, these artifacts can be "*ideas, practices, technical capabilities, and products*

through which the analysis, design, implementation, and use of information systems can be effectively and efficiently accomplished " (Hevner et al. 2004).

A good starting point in understanding design science is the research framework outlined by March and Smith (1995) which categorizes research efforts as a matrix combining four possible research activities (build, evaluate, theorize and justify) and four research outputs or artefacts (constructs, models, methods, instantiations), resulting in a matrix containing sixteen cells describing viable research efforts in information systems (see figure 1 below).

Even though a research shall preferably cover multiple cells of this matrix, it is often admitted that "*the researcher who focuses on the building and evaluation of artifacts will rely less on the building and verification of theory and vice versa*" (Ball 2003). It is crucial to at combine the build and evaluate activities as the evaluation of an artifact gives useful feedback information for improving the quality of the artifact and a better understanding of the problem (Hevner et al. 2004). In effect, the build-and-evaluate loop must often be iterated several times before a satisfactory design of an artifact is generated (Markus et al. 2002).

Our research project aims at covering the building and evaluation of the various artefacts (see Figure 1 below). More specifically, it shall define a set of *constructs* required for describing and reasoning about the environment, integrate them in a *model* showing how they are interrelated, describe a number of analysis *methods* covering the various parts of the model, and implement an *instantiation* of a prototype environmental analysis tool. The *evaluation* of these artefacts is primarily done by their application to concrete case studies and the evaluation of the results with post-interviews with the concerned decision makers.

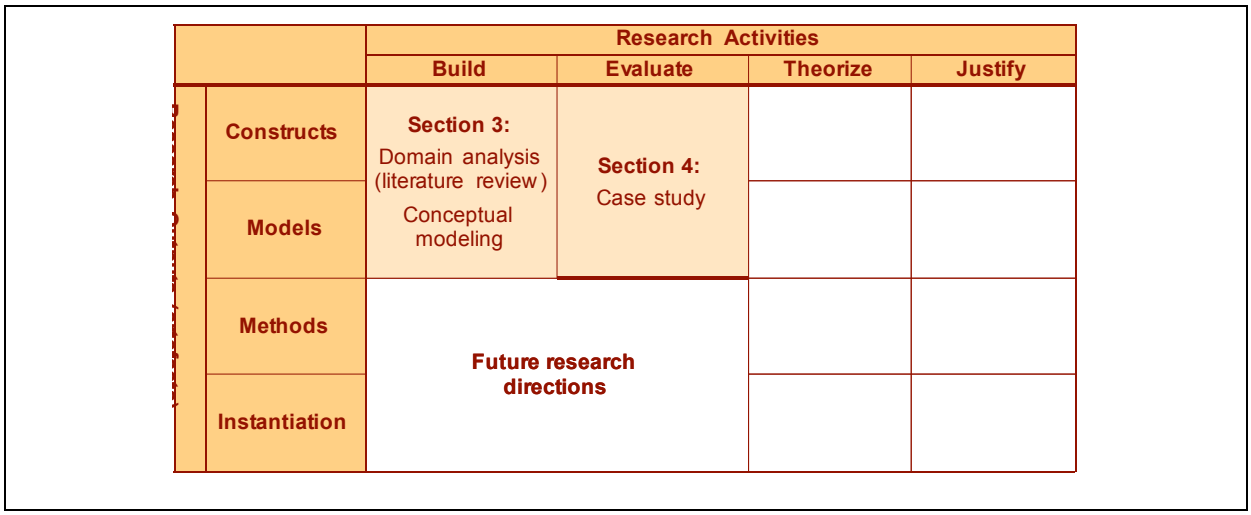

Figure 1: the scope and methodology mix of this research

Alas, the research project depicted in Figure 1 is very broad in scope and is beyond the scope of a single piece of research. As a result, this paper focuses more on the first part of this project and namely covers the building and evaluation of the construct and model artefacts, and only provides an overview of the tools and instantiations that can be based on these artifacts.

The design science framework emphasizes that every cell of this matrix may contain particular research objectives which may require different research methodologies, resulting in an overall methodology mix to be used (March et al. 1995). In our case, we used the methodologies shown in Figure 1 and which are described in more detail at the beginning of sections 3 and 4.

3. Building concepts and the environmental model

The building of the list of constructs and their integration in a conceptual model was carried out using a *domain ontology engineering* methodology, which aims at formalizing the knowledge of a given domain into a domain ontology. This involves four steps: define the

purpose of the ontology; capture the relevant domain entities, formalize them in an ontology and evaluative it (cf. Gruninger 1995; Uschold 1995; Falbo et al. 2002; Gomez-Perez et al. 2004).

As explained above, the *purpose* of the conceptual model presented in this article is to assemble the available but scattered knowledge on environmental scanning and translate it into a more formal model to facilitate the creation of environmental information systems and tools.

The *capture* of the relevant knowledge on the domain to produce this conceptual model is done through an extensive review of the relevant literature in strategic management and related areas such as marketing and information systems. The literature corpus consisted in the set of relevant articles appeared during the 20 last years in the ten management journals with the highest impact factor as calculated by the Social Science Citation Index in 2005 plus the top five additional journals proposed by a recent MIS journals ranking (Rainer et al. 2005)[1] as well as papers that we could obtain through the JSTOR, ABI Inform and Business Source Premier search engines using various sets of relevant keywords. This literature was explored in search of the set of concepts that must be used to describe and reason about the various aspects of the environment of a firm as well as the relationships between these concepts.

In a first step, this literature review has permitted us to identify four principal environmental domains that are considered of strategic importance for the organization. These are the *market*, the *value propositions* demanded by this market to satisfy a given need, the other *actors* in the environment and the *issues* that may influence the future evolution of the environment. These environmental domains can be represented as shown in Figure 2 below.

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[1] The main literature corpus is issued from the following journals (in alphabetical order): Academy of Management Journal, Academy of Management Review, Administrative Science Quarterly, Communications of the ACM, Decision Sciences, Harvard Business Review, Human Resource Management, Information Systems Research, Journal of Management Information Systems, Leadership Quarterly, Management Science, MIS Quarterly, Organization Science, Research Policy, Strategic Management Journal.

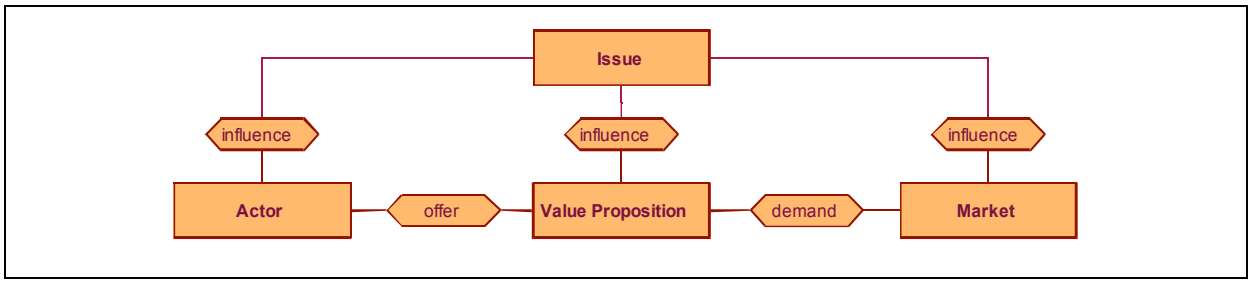

Figure 2: Perspectives of the environment model

Then, in a second step, we investigated the literature in more detail to break these four areas down into a set of more elementary concepts that allow us to analyze the environment. The main challenges encountered in defining this list of concepts were to define an appropriate level of granularity and to overcome the sometimes conflicting names given by different authors to the same concepts. The level of granularity was chosen so as to remain at a sufficiently abstract level to prevent an unnecessary proliferation of concepts and compel the environment analyst to focus on the big environmental picture instead of dispersing efforts by collecting an excessive amount of detail on secondary aspects. This is particularly important in the first stages of environment scanning that requires an undirected bird's eye viewing to guide subsequent more focused search activities purposefully (Aguilar 1967). The choice of vocabulary, in presence of several terms used by different authors to refer to the same concept, followed a guideline consisting in opting either for the term that was used the more often or used by the more prominent authors. The result of this activity is the set of concepts listed and briefly defined in Table 1 below.

	Concept	Definition	Sample references
Market	**Market**	The market is the set of all actual and potential buyers of a market offer.	(Kotler 2003) (McCarthy et al. 1993)
	Market segment	The market segment is a subset of a market composed by a more homogeneous group of customers with similar characteristics, needs and behavior.	(Smith 1956) (Kotler 1989) (Kotler 2003)
	Customer	The customer is an entity who has bought an offering of a firm or might conceivably buy it in the future.	(Narayana et al. 1975) (Peppers et al. 1993) (Kotler 2003)
	Target Market	The part of the market that the company decides to pursue with some value proposition	(Kotler 2003) (McCarthy et al. 1993)
Value Proposition	**Value Proposition**	the statements of benefits that the firm promises to deliver to its buyers so as to satisfy some of their needs	(Kambil et al. 1996) (Bagchi et al. 2000) (Kotler 2003)
	Marketing Channel	The marketing channel is a means that the firm uses to enter in contact, interact with and convey the value proposition to its target customers.	(Anderson et al. 1997) (Moriarty et al. 1990) (Wyner 1995)
	Channel Link	The channel link is a part of a marketing channel which is responsible for a specific marketing task or function.	(Anderson et al. 1997) (Moriarty et al. 1990) (Wyner 1995)
	Technology	Technology refers to any means or knowledge that can be used to achieve a given purpose such as to perform a task, solve a problem or stimulate further innovation.	(Davis 1989) (McOmber 1999) (Rogers 2003)
Actor	**Actor**	An actor is an entity that has the ability to take some actions in the organization's environment which can affect the achievement of the organization's objectives.	(Porter 1980) (Freeman 1984a) (Godet 2001)
	Activity	An activity is a transformation task which uses some inputs and produces some outputs for the purpose of achieving a given objective.	(Porter 1980) (Davenport et al. 1990) (Revaz et al. 1995)
	Resource	A resource is anything tangible or intangible that the firm can use in its processes (e.g. that is needed as input to carry out an activity or is produced as a result of it).	(Grant 1991) (Wade et al. 2004) (Priem et al. 2001)
	Capability	A capability is the ability to combine and mobilize the necessary resources to carry out an activity so as to produce a satisfactory result.	(Barney 1991) (Amit et al. 1993) (Wade et al. 2004)
Issue	**Issue**	An issue is an open and debatable question, event, trend or other forthcoming development that can influence the future conditions of the environment and thus the ability of the firm to achieve its objectives.	(Ansoff 1980) (Dansker et al. 1987) (Godet 2001) (Bendahan et al. 2004)

Table 1: Environmental concepts

After the relevant domain entities have been identified, the *formalization* phase required us to use conceptual modeling techniques to translate this informal knowledge in a formal conceptual

model of the environment. The main challenge encountered in this activity is the choice of an appropriate formalism. After considering several alternatives, we opted for the entity-relationship modeling paradigm (Chen 1976). The reason is it balances formality and understandability: being sufficiently formal to provide an unambiguous representation of the model while being well suited to expose the model to a model to human reader without "*the burden of using a logical level formalism that is sometimes very far from human perception*" (Pigneur et al. 2005).

This paradigm fosters a view of the world as consisting of *entities* (things of the real world that are of interest to the modeler) and *relationships* (associations between two or more entities). Both of them are described by a *semantic definition* and a number of *attributes*. Entities participate in a relationship according to a given *role* (the function it performs) and *cardinality* (the minimum and maximum number of times an entity can participate in the relationship). In addition, a *specialization relationship* is used to define specialized entities that inherit the properties and relationships of a generic entity while adding more specialized ones. These elements are graphically illustrated in a *entity-relationship diagram*. Among the various possible notations (cf. Loos 1993) we opted for a compact notation that does not represent the attributes to obtain immediately readable diagrams using the notation shown in Figure 3.

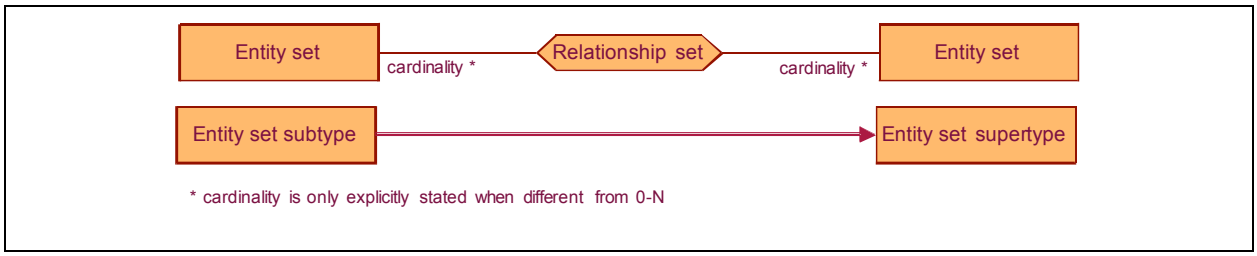

Figure 3: Graphical notation of entity-relationship concepts

In order to introduce the reader progressively into the model, the following sub-sections will first show and briefly comment the four sub-models attached to the four general areas identified

in the capture stage (market, value proposition, actors and issues) before providing, in section 3.5, an image of the complete model. These models only show the elements pertaining to a single area as well as the connection with elements of other areas (displayed in white) in order to allow the reader to not lose the sense of the big picture. In commenting the picture, we will provide a short description of the various entities and relationships, highlighted in bold, with their definitions and their principal properties.

3.1. Market perspective model

The market perspective deals with the demand side of the market and focuses on the customers that the firm wants to serve. It comprises the elements shown in Figure 4 and described below:

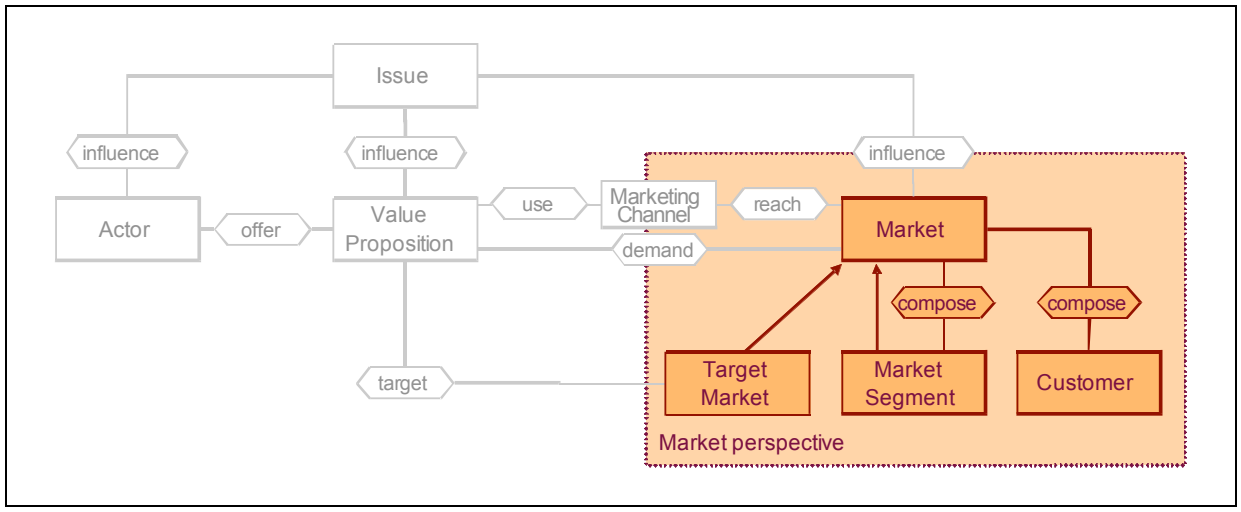

Figure 4. market perspective

The central entity of this area is the **market** that the firm wants to address. It can be simply defined as "*the set of all actual and potential buyers of a market offer*" (Kotler 2003). The market is characterized by a *name*, a *description*, its *boundaries* (which can be described in terms of customer needs, customer types, geographic and product characteristics) and its *attractiveness*

(which can be evaluated using a number of factors like market size, growth, potential, profitability and risk). A market is *composed* of a population of customers, may be composed of a number of market segments, may express a *demand* for some value proposition, may be *reached* by some marketing channel and may *influence* or be influenced by some issues.

Because a market is typically composed by an heterogeneous population of customers, it is often useful to split it into more homogeneous **market segments**. A market segment can be defined as "*a subset of the market composed by a more homogeneous group of customers with similar needs and purchase behaviors*" (Smith 1956). Since, a market segment is itself a market (which can be easily deducted from the definition of market), it inherits its properties (*name*, *description*, *boundaries, attractiveness*) and relationships, but adds in addition the set of criteria that typify its customers and distinguish them from the others segments. Note that since the market segment is modeled as a subtype of market and that the market can be split into segments, the segment can be further split in smaller segments (also called market niches).

As shown by its definition, the market is fundamentally composed by **customers**. They can be defined as *entities that have bought an offering of a firm or might conceivably buy it in the future*. adopt. The importance of understanding customers is evident and demonstrated by the existence of a branch of the marketing discipline dedicated to study the customer behavior. According to this discipline, customers are essentially characterized by a number of *needs*, their incorporation in a number of *desires* to buy specific value propositions to satisfy these needs and a set of *valuation criteria* that they use to evaluate and decide which propositions to buy.

Finally, it is vital to understand the **target market** of the various firms, that is **"***the part of the market that the company decides to pursue with some value proposition*" (Kotler 2003), in order to be able to chose a suitable product-market strategy. The target market is basically a special

type of market, as it is characterized by the same properties and relationship with the exception that it is in addition targeted by some value proposition. Remark that since a market segment is itself a market, a target market can correspond to the whole market, as in the case of undifferentiated strategies, or to a subset of its segments**.**

3.2. Value proposition perspective model

The value proposition perspective deals with the supply side of the market and essentially focuses on competition among the offerings of the various actors and innovation. It includes the elements shown in Figure 5 and described thereafter.

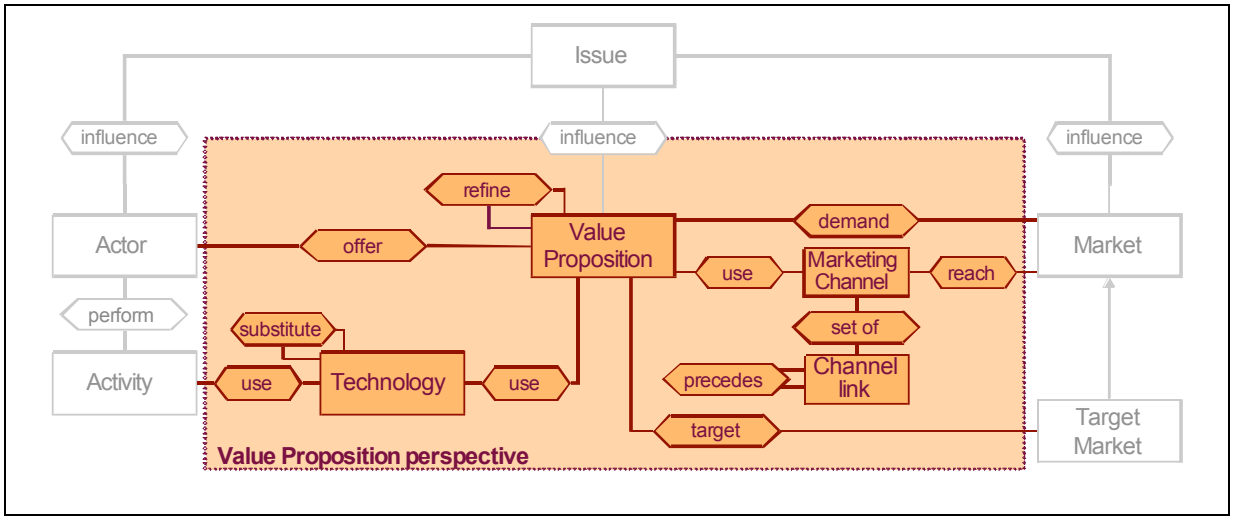

Figure 5. value proposition perspective

The central element of this perspective is the **value proposition**, which is the central element of the competition between the various firms in their fight for gaining a share of the market. The value proposition can be defined as *the statements of benefits that the firm promises to deliver to its buyers so as to satisfy some of their needs (Kambil et al. 1996; Bagchi et al. 2000; Kotler 2003).* In practical terms, the value proposition is made physical by an offering of a combination of products and services. It is essentially characterized by a set of *benefits* which it delivers to its

buyers by satisfying some of their needs and are ideally described by evaluating their performance on the different customers' valuation criteria. It is *offered by* some actor, may *use* some technology, *targets* some target market, it *uses* some marketing channel to reach the market, can have some *demand* from the customers in the market, can be *influenced* by some issue and can be *refined* into increasingly detailed elements (e.g. products and services).

The **marketing channel** is *a means that a firm uses to enter in contact, interact with and convey the value proposition to its target customers*. We distinguish three types of marketing channel that are *used* to make some value proposition *reach* some market: distribution channels that deliver the goods to the customers, communication channels used to enter in touch and convince customers and service channels used to facilitate the transactions with customers and provide after sales support. These channels can be generally characterized by the *benefits* they add to the performance and cost of the value propositions it delivers (Wyner 1995). In order to better understand the channel strategy of a firm, marketing channels can be further *split* into **channel links** that are operated by some actors, deal with some *tasks* of the demand generation cycle like promoting awareness, evaluation, purchase and after sales and can be *linked* to each other, even across channels (Moriarty et al. 1990).

Finally, **technology** is another vital aspects to be monitored as it is a major source of innovation (Roberts 1988) and disruption of established markets and firms (Christensen 1997). It can be defined as *any means or knowledge that can be used to achieve a given purpose like performing a task, solving a problem or stimulating further innovation* (McOmber 1999). Technology It can be characterized by the *benefits* it adds to performance and cost of the value propositions or activities that use it and its *maturity* on the technology life-cycle (Utterback et al.

1975). Technologies can be *used* to improve value propositions, can be *used* to enhance some activities, and can *substitute* some older technologies.

3.3. Actors perspective

The *actors perspective* deals with the other actors active in the environment, their role in the value system and the power relationships between them. It comprises the elements depicted in Figure 6.

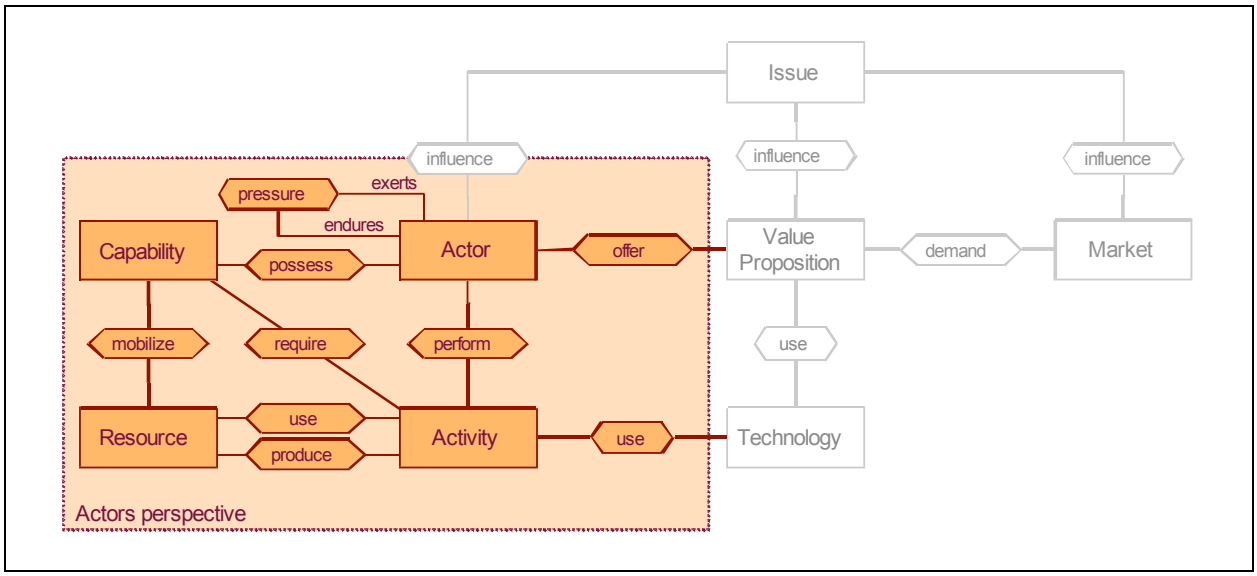

Figure 6. actors perspective

The central element of this perspective is the **actor**, which can be defined as *an entity that has the ability to play a role in the environment by carrying out some activity which can affect or be affected by the achievement of the organization's objectives* (Freeman 1984a). They include the focal organization, its direct competitors, substitute producers, potential new entrants, suppliers and distributors (Porter 1980) as well as all other actors who possess some means to affect them (Godet 2001). An actor is characterized by its *name*, a description of its *business model*, i.e. a representation of the business and money earning logic of a company (Osterwalder 2004), its

strategic profile, an account of the goals, assumptions, strategies and capabilities that affect its strategic decisions (Porter 1980, p47-74), and its *importance*, evaluated by the power, legitimacy and urgency of its claims against the firm (Mitchell et al. 1997). Actors can *offer* some value propositions, *perform* some activity, *possess* some capabilities, *exert* pressure on other actors (using their competitive and bargaining power (Porter 1980), dependencies for goals, tasks or resources (Yu et al. 2001) or other means) and can *influence* or *be influenced* by some issues.

The essential role of the actors is to perform some **activity**, that is the actions that it must perform to achieve its objective (e.g. create and market its value proposition). The activity is generally defined as a *transformation task which uses some inputs and produces some outputs for the purpose of achieving a given objective* (Davenport et al. 1990). It is characterized by its *name*, its *goal*, a *description* of what it does and a *reasoning* describing how it contributes to create value. One problem in modeling the activity of an actor is that it shall be modeled at various levels of abstractions depending on the needs of the user. As a result, we provide a *refine* cyclical relationship on activity so that it is possible to represent the actor's whole value configuration, split it into processes or finally end with its elementary activities. Activities are *performed* by a given actor. The linkages between activities of one or more actors is done by modeling the exchange of resources *produced* by one activity and *consumed* by another, thus allowing the modeler to represent both linkages within the value chain of an actor as well as linkages between actors across the value system (Gordijn et al. 2001).

The **resource** can be defined as *anything tangible or intangible that needed as input to an activity or is produced as a result of it* (Wade et al. 2004). It is essentially used to make the linkage between activities and actors but it can also be a source of competitive advantage as fostered by the resource-based view (Wernerfelt 1984; Barney 1991). It can de described by a

name, a *description,* a *type* - e.g. financial, physical, human, technological, reputation or organizational (Grant 1991) - and a *reasoning* that indicates how it creates value. It can be used or produced by some activity and may require some capability to be mobilized.

Finally, the **capabilities** are another key driver of competitive advantage, especially if valuable, rare, non-imitable and non-substitutable (Barney 1991). They include skills and competencies possessed by employees or codified into organizational processes (Bagchi et al. 2000). It can be defined as *the ability to combine and mobilize the necessary resources to carry out an activity to produce a satisfactory result* (Amit et al. 1993; Le Boterf 2001). It can be described by a *name*, a *description* and a *reasoning* describing why and how it contributes to create value. It can be *possessed by* some actors, be *required by* some activities to be executed properly and to *mobilize* resources correctly.

3.4. Issues perspective

The *issues perspective* deals with the uncertainties that govern the future evolution of the environment and affect the conditions in which strategic decisions will deploy their effects. It comprises the elements depicted in Figure 7 and described below.

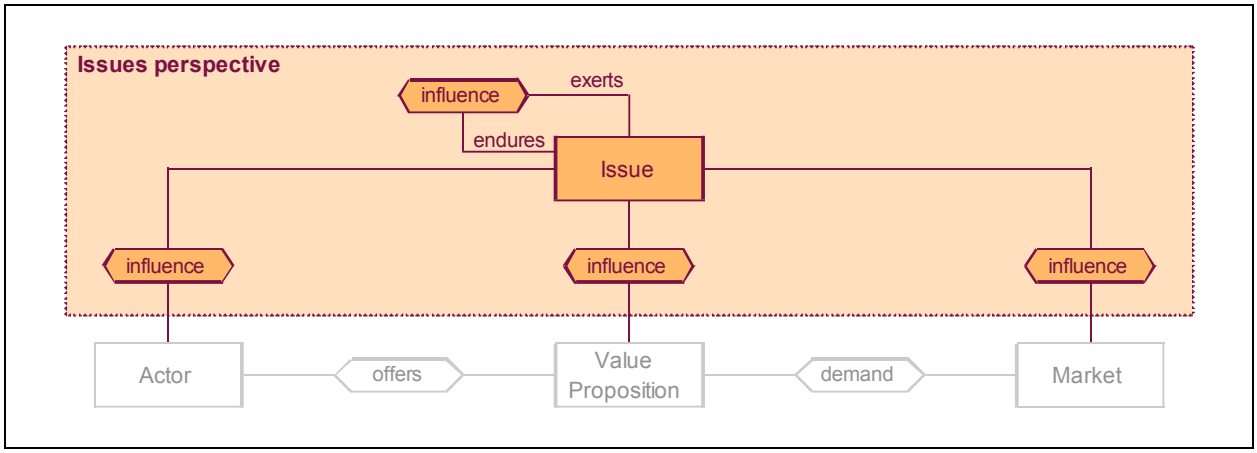

Figure 7. issues perspective

The core element of this perspective is the **issue**. It can be defined as *any force, trend, event or other forthcoming development that can affect the future conditions of the environment and affect the ability of its actors to achieve their objectives* (Godet 2001; Bendahan et al. 2004). An issue is characterized by a range of *possible outcomes* that it may take (Bendahan et al. 2004), a *priority* based on its expected impact and urgency (Ansoff 1980) and the socio-demographic, technological, economic and political *domains* that it arises from (Andrews 1987). The essential role of the issues is that they may *influence* or *be influenced* by the other elements of the model such as other issues (Godet 2001), actors (Godet 2001; Bendahan et al. 2004), markets and value propositions (Kotler 2003). As a result, issues are linked to these elements through bidirectional influence relationships describing the *influencing* and *influenced* elements as well as the *direction* (e.g. positive or negative), *strength* and *timing* of the impact.

3.5. The complete model

At this point, its is possible to show, in Figure 8, an image of the complete model integrating the four sub-models presented before.

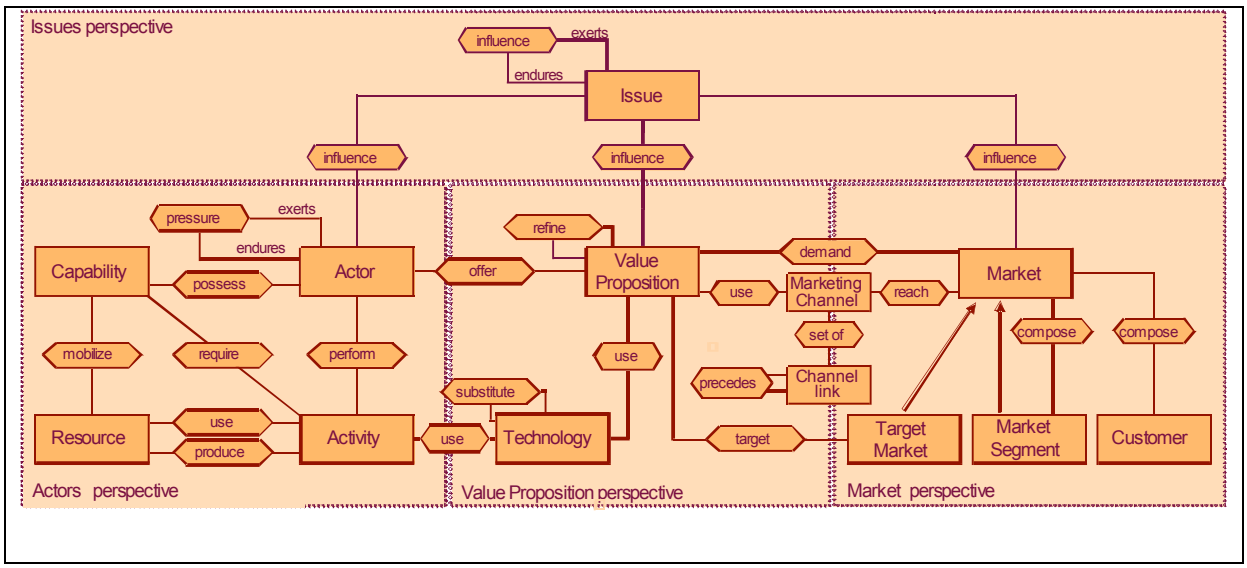

Figure 8. The complete model

4. Evaluation

This section explains the evaluation of the artefacts proposed in the previous section (concepts and model), which is made by applying them to a concrete environment so as to determine their ability to describe they key aspects of a business environment such as an entire industry.

This assessment is done by using a longitudinal case study methodology involving two series of face-to-face interviews with decision makers of the key actors of an industry to collect primary information to produce pictures of the environment and a final phone interview to get their impressions about the resulting application of the model to their industry. This methodology has been chosen because it is ideal when the topic under study is complex, requires a holistic, in-depth investigation and is suited to study the application of information systems in real settings (Kim et al. 2002). An interesting particularity of our application of the case study methodology is that we repeated the case study at two successive times (2002 and 2005) in a sort of longitudinal case study so as to combine a subjective test of its validity done by asking decision makers to evaluate the result of the case study with a more objective test assessing whether our model provides good insights on the possible evolution of the environment by comparing its predictions with the actual evolution of the environment seen at a second time.

In order to conduct this assessment, we have chosen to focus on the Swiss Wireless Internet Service Provider (WISP) industry. The reason of this choice is that this industry was especially interesting in 2002, when we started our longitudinal case study, due to its many unresolved and strategic uncertainties issues that made it one of the hottest topic in the telecom industry, which was unsure about whether it was a potential killer or a useful complementor of traditional mobile operator-centric business models based on cellular technologies like GSM and UMTS (Lehr et

al. 2002) and even as a first step towards more revolutionary self-organized models based on large-scale multi-hop wireless ad hoc networks (Hubaux et al. 2001).

To get the necessary data for the two case studies, two series of semi-structured face-to-face interviews were made with decision makers of the main players in the industry. These included mobile operators (Swisscom, Sunrise, Orange), traditional ISPs (Cablecom, TheNet), pure start-up WISPs (Monzoon, TPN, NetAir), venues (Zurich Airport, CHUV hospital) and wireless communities (Myotis). The interviews lasted between 1 and 2 hours and were structured so as to gather information on all elements of our environmental model.

4.1. First case study

The first case study was conducted in 2002 to show the emergence of the industry. Its results are published in more detail in (Camponovo et al. 2003), which provides a set of case studies on the major firms in the industries that must be omitted here for the lack of space. Hereafter, we will only provide a small account of the main findings of the case study on the four areas proposed by the model proposed in this paper.

Actors. Despite its youngness and an unproven potential, the low entry barriers of this industry attracted a variety of firms with different backgrounds and business models. These comprise the *mobile operators* like *Swisscom* who invested heavily to get preemptive coverage of the best venues to prevent disruption of its core business and extend its cellular services. Swisscom is at present the main WISP player, with a dominant market share (>80%) and the largest network, and appears to have the highest potential to remain the dominant players in the industry due to its possibility to exploit the complementarity with its cellular services, its large resources, renowned brand and established customers base. The two other mobile operators, *Sunrise* and *Orange*, also plan to enter the industry soon. The industry also comprises some

start-ups such as *Monzoon,* the first firm to offer WISP services and the second largest provider with a network of 50 hotspots, *TPN* and *TheNet* who are just starting their business. These players lack the advantages of mobile operators, but may offset them by moving quickly to cover critical venues, position as infrastructure providers or focus on market niches. Some *venues* like hotels, cafes and public institutions also offer WISP services to their customers to complement their offering, but seem to lack the potential to establish as independent WISPs. The *Zurich Airport* may be an exception due to large visitor base, but it prefers to run the infrastructure and rent it to service providers like Monzoon. Some *wireless communities*, like *Myotis*, are also emerging, but have not managed to attract a critical mass of members due to lack of incentives to share and legal concerns. An interesting case is *NetAir*, a start-up with a hybrid commercial and community model based on using private hotspots to sell access to customers and share revenues with their owners. A synthetic image of the industry state in 2002 is provided in Figure 10.

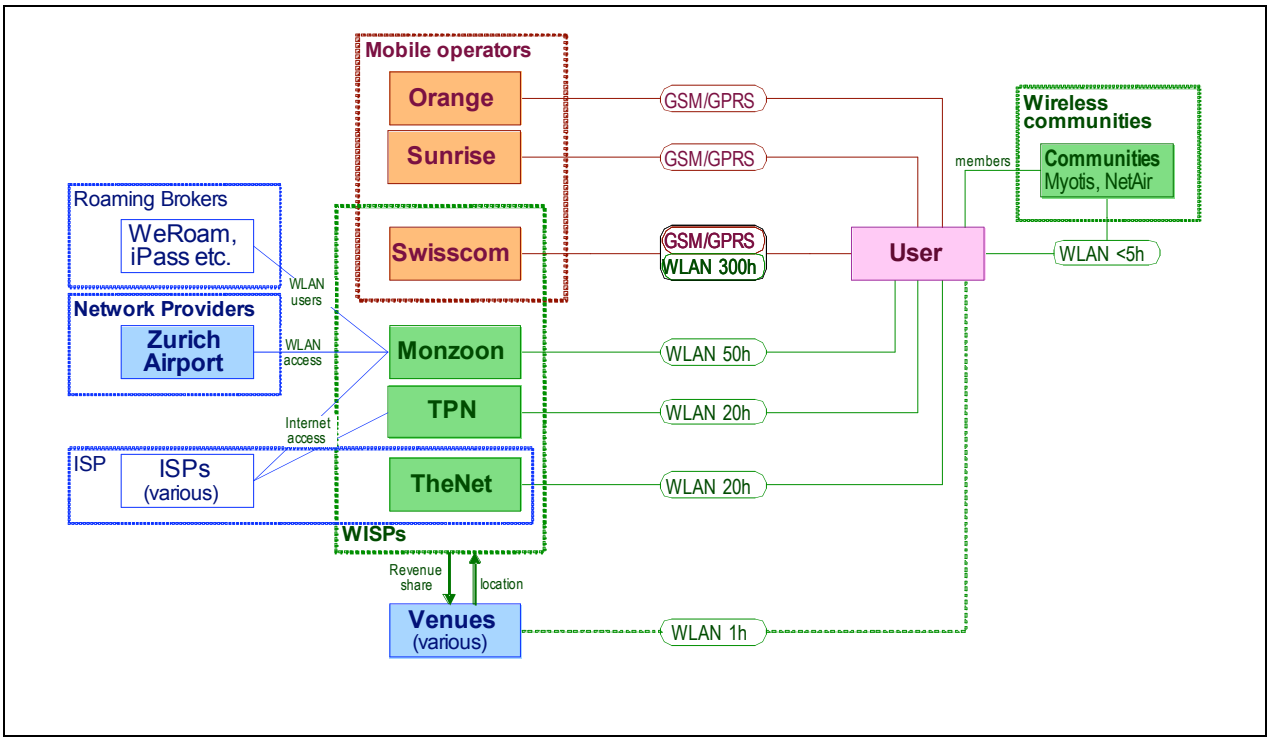

Figure 9: WISP industry in 2002

Value proposition. Most of the value propositions of these actors are technically similar (plain Internet access with 2Mbps data rates) and differentiate only in other areas like the coverage of interesting venues, roaming agreements and the bundling with other services. Swisscom has the only outstanding offering due to its coverage of 300 top venues like hotels and airports and its bundling with cellular and ISP services. Monzoon is second with 50 hotspots, but benefit from the roaming agreements with a few foreign partners. TheNet has a small outdoor offering, but also offers traditional ISP services. The other players are far behind with less than 20 hotspots, mainly in less interesting site. Moreover, most of these value propositions are targeted to the nomadic business segment, with the exception of wireless communities who target the consumer segment and TheNet who targets both segments.

Market. The market for WISP services can be divided into two segments: *nomadic businessmen* and *consumers*. Demand is predictably limited to the nomadic business segment but even their usage is well below expectations hindered by factors like the low diffusion of suitable devices, their limitation to notebooks, the limited coverage of WLAN networks, the absence of roaming, concerns with security and privacy, and high prices. However, most of these factors are only considered to be temporary nuisances which will be resolved by the increasing maturity of the industry and technological progress. This is particularly true for the nomadic business segment, which is expected to grow in the short term. On the other hand, there are more doubts about whether the mainstream consumer segment will ever develop.

Issues. There are several issues that may lead the industry to develop in different directions. The most salient issues, according to a more quantitative analysis of the same industry (Bendahan et al. 2005), include the emergence and sustainability of *free networks*, the coverage of WLAN and the device issue. The former may have an evident impact on commercial

providers, though some users may still be willing to pay for a better quality and get access in some venues, but their ability to attain a critical mass is questioned due to common goods problems (Damsgaard et al. 2004) and legal concerns (Camponovo et al. 2005). The still limited *coverage of WLAN* is another problem that makes it unlikely to achieve a pervasive coverage with WLAN alone, but technological improvements like high gain antennas, mesh networks and handover with cellular networks may solve this problem. Finally, *WLAN devices* are today restricted to notebooks, limiting the market to business users and restraining usage occasions, but PDAs and mobile phones supporting WLAN might come out in the near future, enlarging demand to consumers as well and fostering new applications.

From these elements it appears that, contrary to the prevailing opinions at that time, mobile operators have the highest potential to become the dominant business model due to their existing customer base, known brand and synergies with cellular networks. Pure players may also play a role by offsetting these disadvantages by moving quickly to cover critical venues, position as infrastructure providers or focus on market niches. However, communities are less likely to be successful and may not attain a critical mass due to scalability, legal and security concerns. The market is likely to remain limited to the business segment, at leas in the medium term: unless the device and coverage issues are resolved in the near term, consumers will likely opt for UMTS.

4.2. Second case study

The second case study was conducted in 2005 to show how the industry is organizing around two major business models. Its results are published in more detail in (Camponovo et al. 2006), with a short description of the business models of the various industry participants.

Actors. As shown in the next figure, the industry is organizing around two major business models. The first is *mobile operators* who are taking control of the customer relationship by

offering WISP services in a complete portfolio with cellular services. These now include *Swisscom* (who has consolidated its position and maintained a dominant 80% market share), *Sunrise* and *Orange* (who entered the industry later, relying on the network provided by other providers, and gained around 10% market share each). *Cablecom* (the largest Swiss cable TV and ISP operator) entered the industry in the same way with similar results. The second business model is given by the former pure player start-ups which have mainly positioned as *neutral network operators*, focusing on deploying and operating the WLAN network at the venues and providing access on a wholesale basis to other service providers who resell the service under their own brand. These comprise *Monzoon*, *TPN* and *TheNet*. Some smaller WISPs, venues and communities are still in the industry, but are insignificant except the Zurich Airport. Finally, new players like *civic networks* and *community projects* like FON are appearing in the industry.

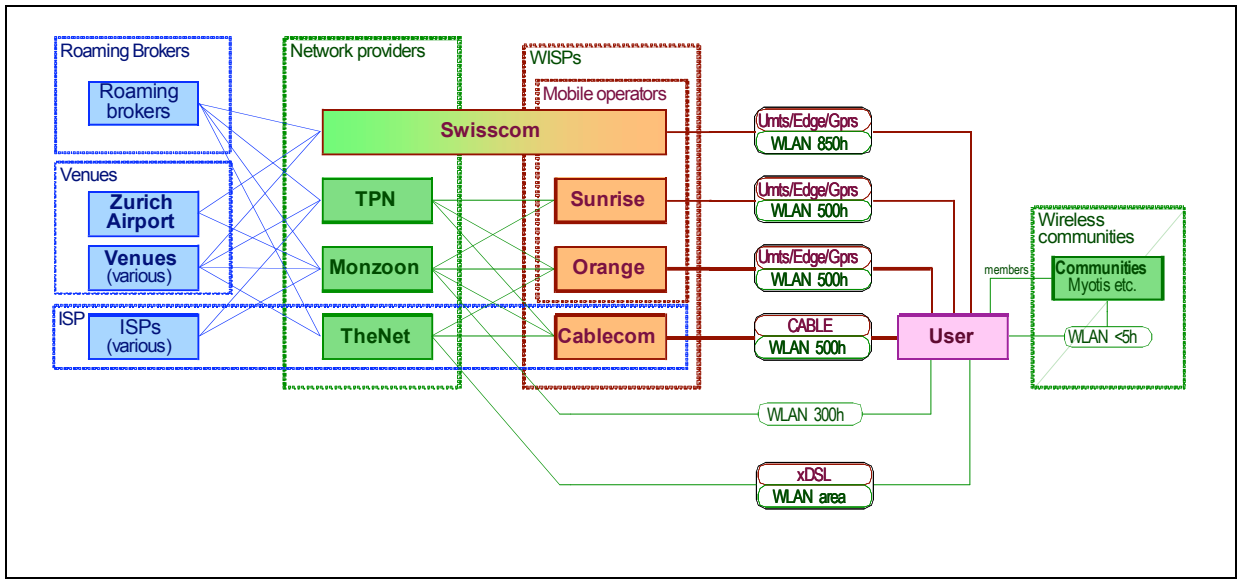

Figure 11: WISP industry in 2005

Value propositions. The value propositions of these players have continued to improve in terms of speed (due to better xDSL backhaul networks) and usability but are still very similar. Network coverage and bundling are still the critical differentiation factors: Swisscom still has the

largest network (850 hotpots) and the best bundling (with its Unlimited UMTS/GPRS/WLAN card), but *Sunrise* and *Orange* are now closer with 500 hotspots (operated by other players) and offer similar bundling offerings. Cablecom has a similar WLAN coverage but offers a bundling with traditional ISP services. Monzoon, TPN and TheNet mostly focus on providing the infrastructure to other WISPs, though Monzoon also maintained its end user offering and TheNet offers it as a bundle with its traditional ISP products.

Market. Demand for WISP services has steadily increased arriving to a total market volume of five to ten millions. As predicted, this is mostly generated by the *nomadic businessmen* segment, while the *consumer* segment has never really taken off. However, there are positive signals for a continuing growth driven by the rising availability of devices like WLAN PDAs and phones, growing coverage, integration with cellular services and emergence of new applications.

Issues. Finally, while the industry attained a more stable form, there still are several issues which may alter it. The same issues of the first case are still here but are generally less uncertain. In particular, *WLAN devices* like PDAs and phones are coming to the market and *coverage* is expanding. The situation on *free networks* is less clear: they have hardly developed but the emergence of firms like FON may foster the creation of global community network. In addition, new issues have appeared like the adoption of *voice over WLAN* application and the emergence of *WiMax*.

4.3. Validation

These two case studies were initially validated by showing the result to the same decision makers and by asking them to judge the fidelity, accuracy and completeness of the resulting description of the industry. To do so, we presented them a conference paper version of the case studies shown above (Camponovo et al. 2003; Camponovo et al. 2006) and asked them via a

short phone interview about whether it describes the situation of their industry accurately, whether all aspects were relevant, whether important elements were missing and whether they had other comments.

Overall, the experts found that the paper provided an accurate picture of the industry and were happily impressed with the original approach of contrasting the two time periods. None of the experts mentioned important elements that were missing, but sometimes found that it provided a low amount of detail, which is probably partly due to the shortness of the paper presented to them and partly due to the larger focus on an exploratory environmental analysis, which typically serves to point out a number of interesting issues which shall be researched in more detail. In addition, they also formulated a few interesting corrections and suggestions that have been taken into account in rewriting the cases.

To complement the subjective evaluation of the experts with a more objective validation, we also performed a test judging whether the representation of the industry obtained with our first case study (that was constructed on the basis of our model) provided better insight on the evolution of the environment than the prevailing opinions at that time. In practical terms, this was done by comparing the predictions formulated from the discussion of the results of the first case study (cf. Camponovo et al. 2003) and the prevailing opinions with the actual evolution of the environment as captured in the second case study (cf. Camponovo et al. 2006).

In this respect, the examination of the situation described in the second case study with the insight generated by the first one suggests that the application of our model proved a better indicator of the actual evolution of the industry than the prevailing views of the industry at that moment. A summary of the major factors analyzed in this test is provided in Figure 12.

	Reality	Prevailing vision	Model
Disruption against mobile operators	**Complementarity** coexistence with newcomers	**Disruption** newcomers displace operators	**Complementarity** coexistence with newcomers
Role of pure WISPs	**Limited** neutral network provider position	**Important** main providers to end users	**Niche** quickly cover venues to survive
Role of venues	**Limited** most let WISP offer the service	**Important** offer own WISP services	**Limited** let WISP offer the service
Market development	**Limited** nomadic busines segment	**Limited** nomadic busines segment	**Limited** nomadic busines segment
Free networks	**Limited** marginal and with low size	**Important** free networks would dominate	**Important** large alternative free networks

Figure 12: Evaluation of our model with respect to the evolution of the industry

In particular, Figure 12 shows that the use of our model allowed us to better predict the role of the various actors in the industry than the prevailing wisdom at that time. In particular, unlike most of the other writers that claimed that WLAN was poised to disrupt the traditional mobile network operator business models in the mobile industry, the study conducted on the base of our model we highlighted several reasons to believe that this was not the most likely future evolution of the industry but that mobile network operators were more likely have taken control of this industry by taking advantage of the complementarity between cellular and WLAN to offer a better value proposition as well as the possibility to leverage their known brands, existing customer bases and channels to gain the customer relationships. Conversely, our study also stated that pure players were not likely to dominate this industry, but still had a chance to establish a defendable niche positions in the industry by moving quickly to cover the most attractive venues with exclusive contracts and position as infrastructure providers, selling connectivity to other service providers like mobile operators to integrate the service in a more global offering and it to the end customer.

Both of these insights were confirmed by the evolution of the industry since mobile operators have taken advantage of their huge existing user bases and bundled value propositions to take

control of the customer relationships and position as the central actors of the industry, while pure players have been able to hold a place in the industry despite the inroad of the mobile operators through the exclusive coverage of attractive venues, though they had to partially abandon the end user market to position as neutral infrastructure operators.

In addition, our model allowed us to correctly point out that venues were not likely to engage directly in the provision of WISP services but that they were expected to focus on their core business while letting specialized providers offer WISP services at their venues in exchange of some revenue sharing. This was again contrasting with the opinion of many writers that venues would benefit from this technology to position as important actors of the industry. In reality, despite the noteworthy exception of the Zurich Airport, who operates its own WLAN network but still let specialized service providers offer the service to its visitors, and a few insignificant venues, most venues like hotels, restaurants and cafés do let specialized firms offer WISP services at their venue.

On the other hand, our model was as good, or as bad, as the prevailing opinions at predicting the evolution of the market and the outcome of a number of issues. On the positive side, our model aligned with the prevailing opinion in expecting the market to be limited to the business segment, at least in the medium term. On the negative side, we also overestimated the emergence of free community networks, despite raising some issues that could have hindered it, that have insofar developed much less and had a much weaker impact than we have originally thought. However, we believe that this is still an actual issue and that it may be fostered by initiatives of new firms like FON and civic networks though there still are various problems that may hinder them to get a critical mass like the problem of finding of a balanced set of incentives for members participate to share their access points and the legal concerns linked with this practice.

As a result, we can state that the two subjective and objective validation tests described above allowed us to respectively show that 1) our model can be successfully used to get a complete and accurate picture of a concrete environment and that 2) it can be used to get good insights on its potential future evolution or at least identify the issues that are most likely to determine it.

5. Conclusions and future research directions

As explained in the introduction, this paper employs a design science approach to provide a solution to the problem caused by the lack of research on environment scanning aimed at producing a reference framework that can be used to conceive suitable environment scanning information systems and tools.

Inspired by previous research in the domain of enterprise ontologies, we developed in this paper a conceptual model of the environment could help solve this problem by assembling the available but scattered knowledge on this topic and translating it into a more formal form to facilitate the creation of environmental information systems and tools. More specifically, the model can ease the achievement of this objective by providing a reference framework identifying the relevant aspects of the environmental that can be used to specify suitable environmental information system requirements, design the underlying data repository, identify and integrate the various existing tools that can be used for collecting, analyzing and visualizing such data, understand where original developments must be made, and providing a set of more formally defined and hence actionable foundations to facilitate such developments.

In addition, we tested the validity of the model by using it as a basis to conduct a case study on the concrete environment formed by the Swiss WISP industry, validating the validity and completeness of the results through interviews with decision makers of the same industry and

verifying its ability to generate useful insights on its possible future evolution by testing whether the use of the model is able to better predict the actual evolution of the industry.

In the methodology section we stated that this paper describes only the first part of a more ambitious research project aiming at fostering the creation of a comprehensive environmental toolbox for analyzing the various relevant aspects of the environment.

In the introduction, we stated that the conceptual model of the environment provided in this paper can be a good starting point in achieving this objective by providing a framework that can be used to identify the existing tools that can be used to analyze the various relevant aspects of the environment, understand where original developments must be made to cover the gaps in the existing tools, and facilitate their integration by using a common underlying data repository based on the model.

While it is beyond the scope, and space, of the paper to provide a detailed description of such a toolbox, we nevertheless want to provide some preliminary insights on how the model can be used as a basis for achieving this objective. To do so, we examined the same literature corpus described above in search of tools that can be used to analyze information on the various aspects of our model. We have regrouped in the following table a representative sample of the existing tools that cover the various environmental aspects together with a short description of their goal, a specifications of the part of the model that they require as data model and some references.

Finally, note that on the basis of this preliminary literature review of the tools and with the guidance of the model, we already were able to spot a few gaps in the existing corpus of tools and to either propose some extensions, for instance by integrating the actors perspective in the technology roadmapping technique as described in (Camponovo et al. 2004) and by integrating and enhancing the two major multi-actor multi-issue analysis tools to create a new method,

called MASAM, and implementing it in a new prototype offering enhanced visualization as shown in (Bendahan et al. 2005).

Name	Goal	Concepts covered	References
Product-market matrix	Facilitate selection of a target market strategy	Market segment, Value proposition, Actor	(Ansoff 1957) (Kotler 2003)
Strategic canvas	Compare value propositions to find differentiation options	Value proposition, Customer, Actor	(Kim et al. 2002) (Koch 2000)
Multi-criteria decision making methods	Compare value propositions on multiple criteria	Value proposition, Customer	(Roy 1968) (Triantaphyllou 2000)
Value map	Compare value propositions to find differentiation options	Value proposition, Customer	(Kambil et al. 1996)
Hybrid Grid	Facilitate the development of a marketing channel strategy	Marketing channel, Channel link, Actor, Value proposition	(Moriarty et al. 1990)
Disruptive technology detection framework	Evaluate the disruptive potential of technologies	Technology	(Rafii et al. 2002)
Technology roadmap	Manage the links between technology, products, market	Technology, Value proposition, Market segment, Actor	(Phaal et al. 2004) (Camponovo et al. 2004)
BCG matrix	Manage the portfolio of business units of the firm	Actor, Value proposition, Market	(Henderson 1973) (Brownlie 1985)
Business model ontology	Describe the business logic of a firm	Target market, Value proposition, Channel, Activity, Capability etc.	(Osterwalder 2004)
Value configuration	Describe the value creation infrastructure of a firm	Activity, Resource, Actor	(Porter 1980) (Stabell et al. 1998)
E^3 Value ontology	Describe the value system in which the firm is in	Actor, Activity, Resource, Value proposition, Target market	(Gordijn et al. 2001) (Gordijn 2002)
Competitive pressure systems mapping	Describe the pressure among actors in an industry	Actor, Value Proposition, Market	(Freeman 1984b) (D'Aveni 2002)
I* strategic actor relationships modeling	Describe the various linkages between actors	Actor, Activity, Resource, Capability, Pressure	(Yu et al. 2001)
MICMAC structural analysis	Evaluate the importance of the various issues	Issue, Influence	(Arcade et al. 1999) (Godet 2001)
MACTOR actor's strategy analysis	Evaluate potential actor's strategies to influence issues	Actor, Issue, Influence, Pressure	(Arcade et al. 1999) (Godet 2001)
NEGOTIATOR	Facilitate negotiation of many actors on many issues	Actor, Issue, Influence	(Allas et al. 2001)

Table 2: A summary of the environment analysis tools specified in this chapter

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